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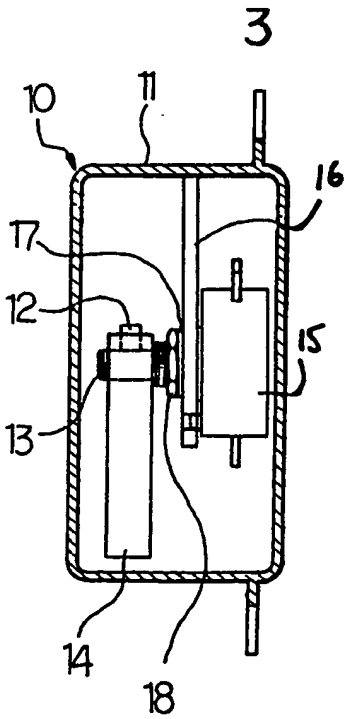
WO 79/00330 A1 US 3865265 A

(58) Field of Search
UK CL (Edition M) B8H HFD , B8L LFB LFC LFX , G1N NACNI
INT CL[5] B66C 15/06 , B66F 9/08 17/00

(54) Tilt angle sensor

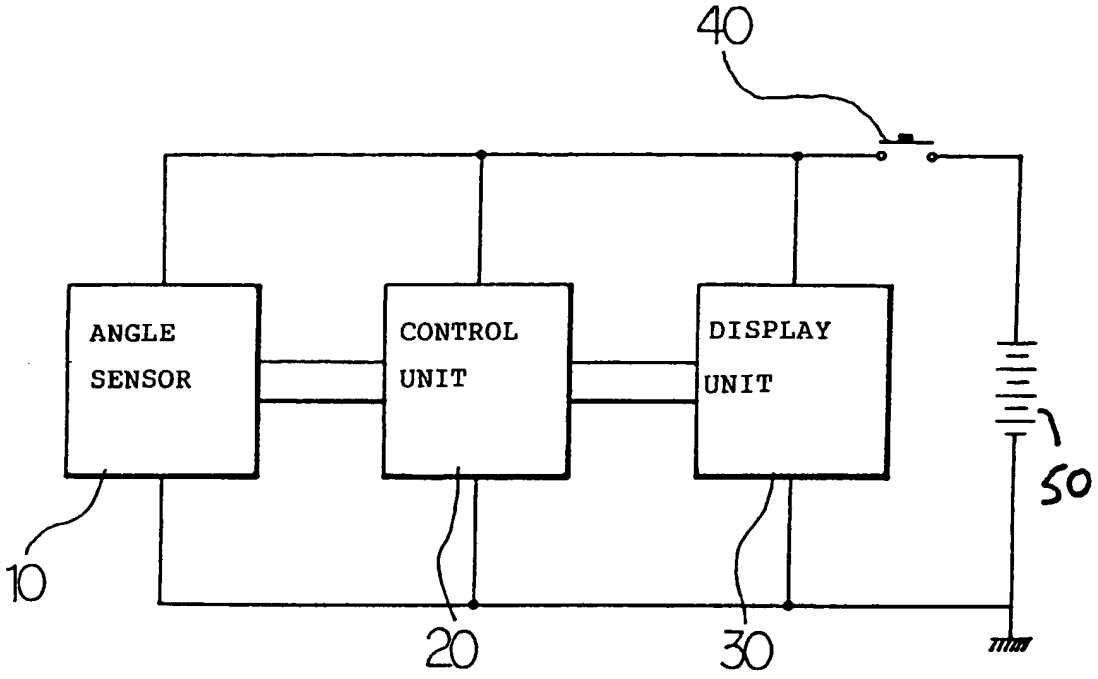
(57) An apparatus for displaying a tilt angle in loading equipment, including an angle sensor unit 10 mounted to a mast of the loading equipment and provided with a rotation shaft 13 rotating upon the tilting of the mast, the angle sensor unit serving to detect an absolute tilt angle of the mast with respect to a horizontal ground in the form of an electrical signal, based on a rotation amount of the rotation shaft, a control unit adapted to concert the angle sensing signal received from the angle sensor unit into a corresponding angle, discriminating whether the tilt of the mast corresponds to a forward tilt or a rearward tilt, and controlling the display for the absolute tilt angle of the mast on the basis of the result of the discrimination, and a display unit adapted to display the tilt angle on the basis of display data received from the control unit, whereby the apparatus can display an absolute tilt angle corresponding to a composition of the tilt angle of the mast and the tilt angle of the loading equipment, thereby achieving safer and more convenient loading and unloading work. The rotation shaft 13 has a weight 14 fixed to it to indicate the tilt of the machine relative to the ground.



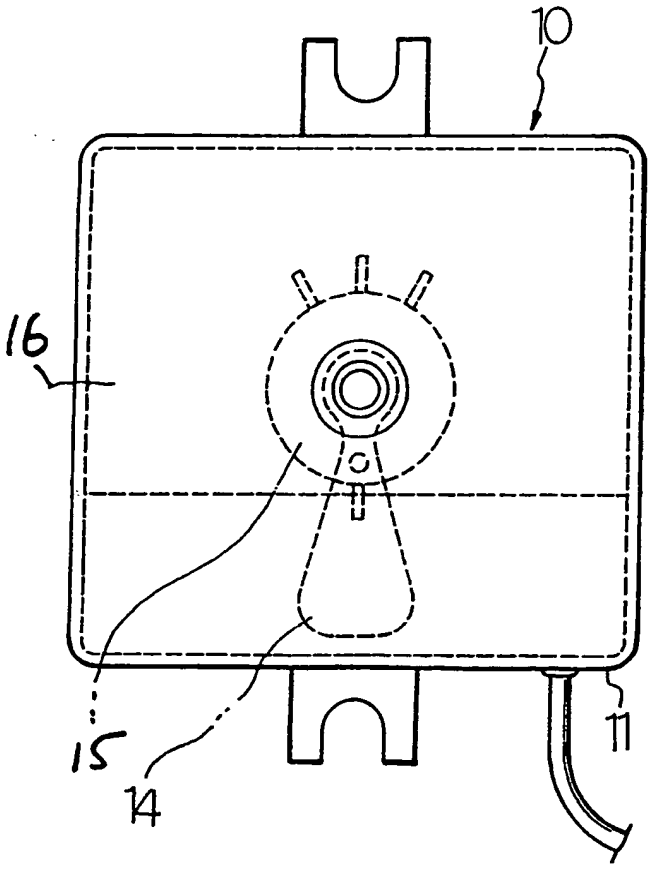
GB 2 285 250 A

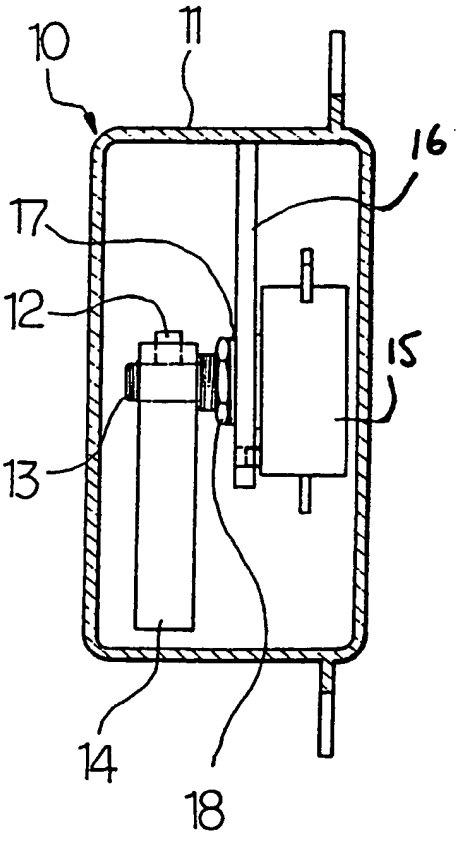
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

1


40
ANGLE SENSOR
CONTROL UNIT
DISPLAY UNIT
50
10
20
30

2 3


10
16
15
14
11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11
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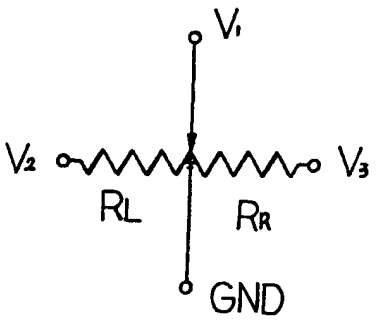
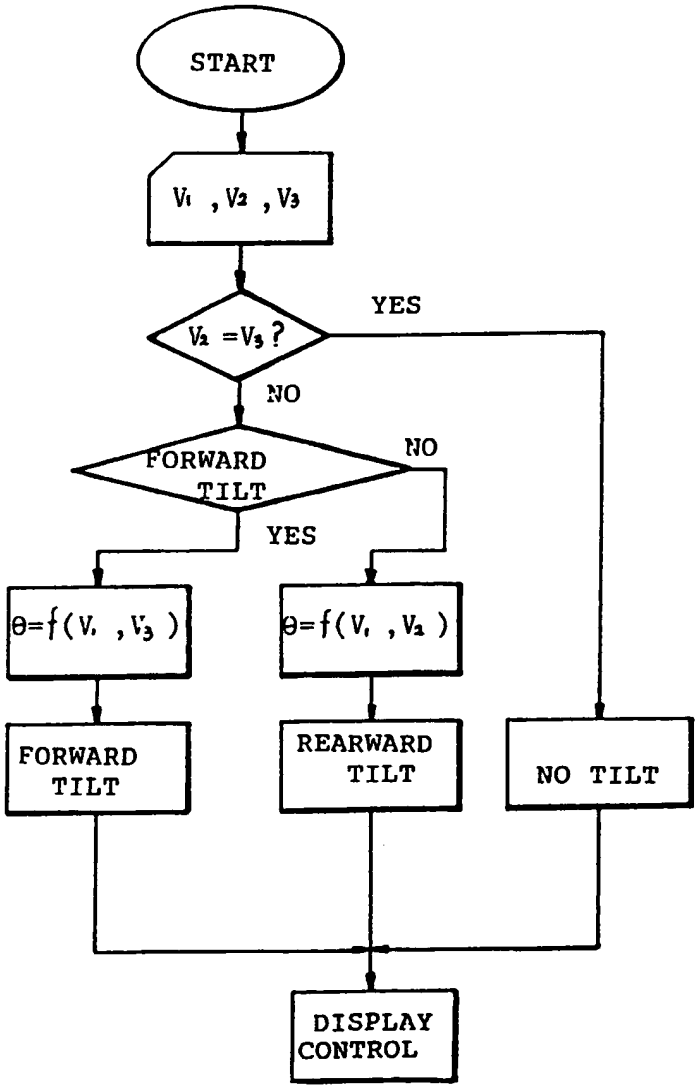
17
12
15
13
14
18

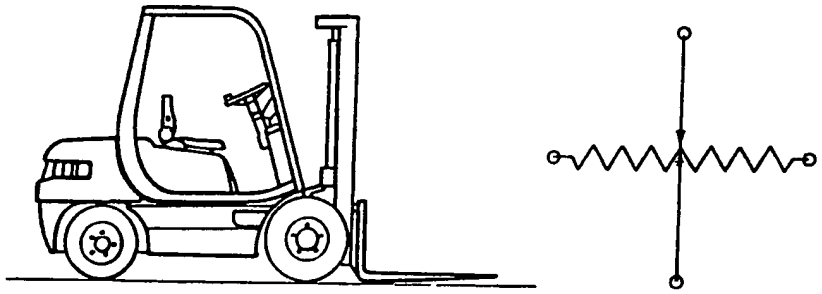
4


V1
V2
V3
RL
RR
GND

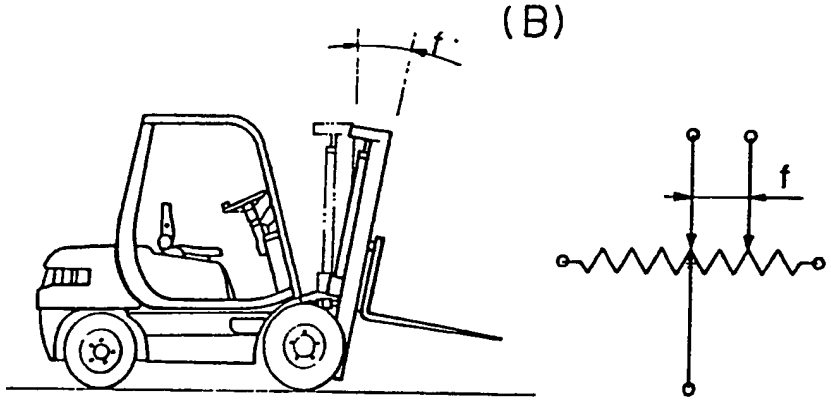
5


START
V1 , V2 , V3
V2 =V3 ?
YES
NO
FORWARD TILT
NO
YES
θ=f(V1 , V3)
θ=f(V1 , V2)
FORWARD TILT
REARWARD TILT
NO TILT
DISPLAY CONTROL

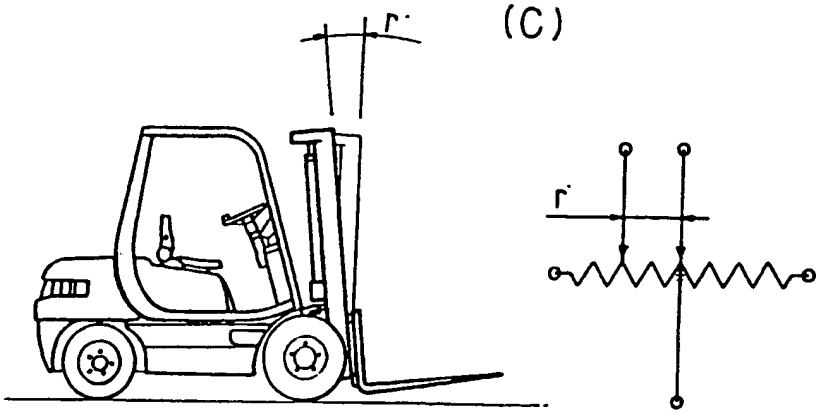
(A)



(B)



(C)



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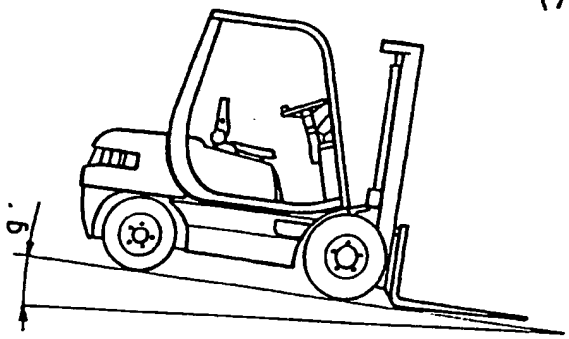

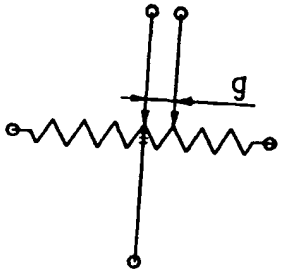

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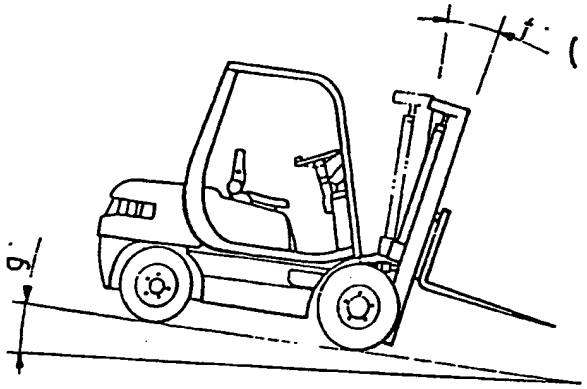
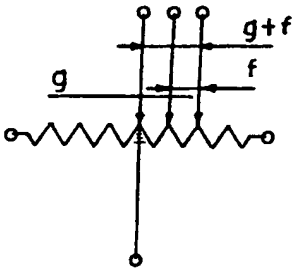
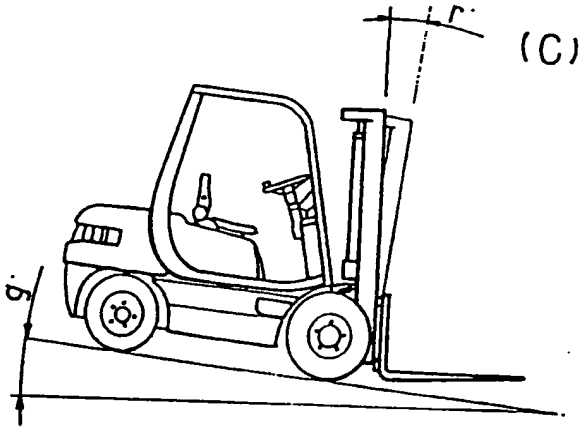
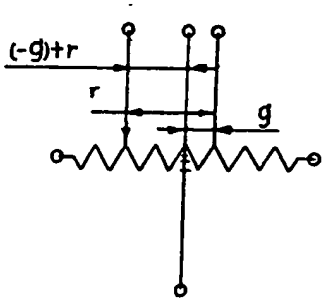




(C)





APPARATUS FOR DISPLAYING TILT ANGLE OF LOADING EQUIPMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus for displaying a tilt angle of loading equipment, and more particularly to such a display apparatus capable of displaying the tilt angle of a mast in a forklift and thereby achieving safer loading and unloading work.

2. Description of the Prior Art

Such a display apparatus used in loading equipment is well known. In the conventional display apparatus, a tilt angle of a mast is displayed by converting the operated amount of a tilt cylinder or the rotated amount of the end of a rod in the form of an angle.

However, such a display method can not display an actual tilt angle indicative of the angle of the ground combined with the tilt of the mast because it displays only the tilted condition of the mast in the loading equipment, that is, the relationship between the mast and the loading equipment without taking into consideration the condition of the ground on which the loading equipment is disposed.

As a result, several problems occur during loading and unloading operations of the forklift due to a difference between the actual tilt angle (absolute tilt angle), corresponding to the composition of the ground slope and the mast tilt, and the tilt angle being displayed.

Furthermore, the above-mentioned display method has a drawback in that the display of the tilt angle is possible only in the range of operation amount of the tilt cylinder.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide an apparatus for displaying a tilt angle of loading equipment, capable of achieving safer and more convenient loading and unloading work by displaying a tilt angle corresponding to the angle of the slope of the ground on which the loading equipment is disposed combined with the tilt of a mast upon the loading and unloading work.

Another object of the present invention is to provide an apparatus for displaying a tilt angle of loading equipment, capable of detecting the tilt angle in the range from forward 90° to rearward 90° and displaying it.

In accordance with the present invention, this object can be accomplished by providing an apparatus for displaying a tilt angle in loading equipment, including an angle sensor unit mounted to a mast of the loading equipment and provided with a rotation shaft rotating upon the tilting of the mast, the angle sensor unit serving to detect the absolute tilt angle of the mast with respect to a horizontal ground in the form of an electrical signal, based on the rotational amount of the rotation shaft; a control unit adapted to convert the angle sensing signal received from the angle sensor unit into a corresponding angle, discriminate whether the tilt of the mast corresponds to a forward tilt or a rearward tilt, and control a display for the absolute tilt angle of the mast on the basis of the result of the discrimination; and a display unit adapted to display the tilt angle on the basis of display data

received from the control unit.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and aspects of the invention will become apparent from the following description of embodiments with reference to the accompanying drawings in which:

FIG. 1 is a block diagram illustrating an apparatus for displaying the tilt angle of loading equipment in accordance with the present invention;

FIGs. 2 and 3 are a front view and an elevation view of an angle sensor unit in accordance with the present invention, respectively;

FIG. 4 is a circuit diagram illustrating an equivalent circuit of a sensor of the angle sensor unit shown in FIG. 3;

FIG. 5 is a flow chart illustrating a control procedure of a control unit shown in FIG. 1;

FIGs. 6A to 6C are schematic views respectively illustrating detection of a horizontal condition of a forklift, a rearward tilted angle and a forward tilted angle;

FIGs. 7A to 7C are schematic views respectively illustrating detection of a horizontal condition of a forklift with respect to a slant ground, a rearward tilted angle and a forward tilted angle.

PREFERRED EMBODIMENTS OF THE INVENTION

FIG. 1 is a block diagram illustrating an apparatus for displaying the tilt angle of the loading equipment in accordance with the present invention. FIGs. 2 and 3 are a front view and an elevation view of an angle sensor unit in accordance with the present invention, respectively.

As shown in the drawings, the apparatus includes an angle sensor unit 10 mounted on the mast of the loading equipment and adapted to detect the absolute tilt angle of the mast using a rotation balance and generating an electrical signal indicative of the detected absolute tilt angle, a control unit 20 adapted to convert the angle sensing signal received from the angle sensor unit 10 into a corresponding angle, which discriminates whether the sensed tilt corresponds to a forward tilt or a rearward tilt, thereby controlling the display based on the absolute tilt angle of the mast with respect to the horizontal ground, and a display unit 30 adapted to display the tilt angle, based on display data received from the control unit 20.

As shown in FIGs. 2 and 3, the angle sensor unit 10 includes a sensor case 11 and a sensor 15, such as a potentiometer, fixedly mounted on one end of a rotation shaft 13 fixed to a fixed plate 16 disposed in the sensor case 11 by means of a washer 17 and a nut 18. The potentiometer 15 has a resistance variable depending on the rotation angle and direction of the rotation shaft 13. In opposition to the potentiometer 15, a rotation balance 14 is fixedly mounted to the

other end of the rotation shaft 13 by means of a screw 12.

The angle sensor unit 10 mounted on the mast of the loading equipment is maintained under conditions shown in FIG. 2. The sensor case 11 is fixed to one side portion of the mast. As the mast tilts, the sensor case 11 is correspondingly tilted. At this time, however, the rotation balance 14 rotates so that a state normal to the horizontal ground is maintained by virtue of its weight. The rotation shaft 13 rotates by the rotation of the rotation balance 14, thereby causing the potentiometer 15 to rotate.

As shown in the equivalent circuit of FIG. 4, the potentiometer 15 includes a variable resistor connected at its central portion to the ground GND. The potentiometer 15 also includes a movable terminal for generating a variation in resistance depending on the rotated amount of the rotation shaft 13. A pair of variable resistance regions RL and RR are defined in both sides of the movable terminal, respectively.

With such a construction, the potentiometer 15 can detect the tilt angle of the mast, based on a voltage V1 detected at the movable terminal and voltages V2 and V3 detected at respective ends of the variable resistance regions RL and RR. The potentiometer 15 generates a signal indicative of the detected tilt angle of the mast and sends it to the control unit 20 which, in turn, converts the received signal into a corresponding tilt angle and controls the display unit 30 to display the tilt angle.

The variable resistance regions RL and RR of the potentiometer 15

have variable ranges corresponding to tilt angle sensing ranges of forward 90° and rearward 90° respectively.

Now, operation of the apparatus having the above-mentioned construction in accordance with the present invention will be described.

As the mast, on which the angle sensor unit 10 of the present invention is mounted, tilts through a certain angle, the overall elements of the angle sensor unit 10 except for the rotation balance 14 are correspondingly tilted. At this time, the rotation shaft 13 supporting the rotation balance 14 rotates through the tilt angle of the mast. As a result, the movable terminal of the potentiometer 15 is shifted along the variable resist toward one end of the variable resist, thereby varying the difference between the voltage V1 at the movable terminal and the voltage V2 at one end of the variable resistor and the difference between the voltage V1 at the movable terminal and the voltage V3 at the other end of the variable resistor.

The control unit 20 which calculates the tilt angle, based on the tilt angle sensing signal received from the potentiometer 15 and controls the display unit 30 to display the calculated tilt angle. This operation of the control unit 20 is carried out in accordance with a control procedure shown in FIG. 5.

That is, when the apparatus is energized, the control unit 20 initializes the movable terminal-side voltage V1 and the end-side voltages V2 and V3 so that they have values at the horizontal condition, respectively.

Thereafter, the control unit 20 compares the end-side voltages V2 and V3 with each other to determine whether they are identical to each other. When the end-side voltages V2 and V3 are identical to each other, the control unit 20 determines that the current condition corresponds to the horizontal condition. In this case, the control unit 20 controls the display unit 30 to display "no tilt".

In other words, when the forklift is disposed on a horizontal ground and maintained under the horizontal condition, as shown in FIG. 6A, the movable terminal of the potentiometer 15 is positioned at its central position, so that the end-side voltages V2 and V3 are identical to each other.

If the end-side voltages V2 and V3 are different from each other, then the control unit 20 determines whether the current condition corresponds to the forward tilted condition or the rearward tilted condition. Where the current condition corresponds to the forward tilted condition through an angle of f° as shown in FIG. 6B, the tilt angle θ is derived in accordance with a function operation of [θ = f(V1,V3)] based on the movable terminal-side voltage V1 and the right end-side voltage V3. The derived tilt angle θ is sent to the display unit 30 so that the display unit 30 can display the forward tilted condition through the angle θ. In this case, the tilt angle θ corresponds to the angle of f° because the forklift is disposed on the horizontal ground.

Where the current condition corresponds to the rearward tilted condition through an angle of r° as shown in FIG. 6B, the tilt angle θ

is derived in accordance with a function operation of [θ = f(V1,V2)] based on the movable terminal-side voltage V1 and the left end-side voltage V2. The derived tilt angle θ is sent to the display unit 30 so that the display unit 30 can display the rearward tilted condition through the angle θ. In this case, the tilt angle θ corresponds to the angle of r° because the forklift is disposed on horizontal ground, as in the case of the forward tilted condition.

On the other hand, where the ground on which the forklift is disposed has a slope, the tilt angle of the mast is displayed, taking into consideration both the slope of the ground and the tilt angle of the forklift. This will be described in conjunction with FIGS. 7A to 7C illustrating the condition that the ground has a slope of g° . FIG. 7A shows the condition that the forklift is forward tilted due to the slope of the ground while the mast does not tilt with regard to the body of the forklift. In this case, the potentiometer 15 detects a tilt sensing value indicative of the angle of g° through which the forklift is forward tilted. Based on the detected tilt sensing value, the actual tilt angle of the mast is derived in accordance with the function operation of [θ = f(V1,V3)] for calculating the forward tilt angle. The derived tilt angle θ is then displayed by the display unit 30.

Where the forklift is tilted forward through the angle of g° corresponding to the slope of the ground while the mast is tilted forward through the angle of f° with regard to the body of the forklift, as shown in FIG. 7B, the potentiometer 15 detects a tilt sensing value indicative of the angle of g° + f° . Based on the detected tilt sensing

value, the actual forward tilt angle (absolute tilt angle) of the mast is derived and displayed in the same manner as in the case of FIG. 7A.

On the other hand, where the forklift is forward tilted through the angle of g° corresponding to the slope of the ground while the mast is rearward tilted through the angle of r° with regard to the body of the forklift, as shown in FIG. 7C, the potentiometer 15 detects a tilt sensing value indicative of the angle of -g° + r° . Based on the detected tilt sensing value, the actual rearward tilt angle of the mast is derived and displayed. When the slope of the fork truck, namely, the angle of g° is larger than the tilt of the mast, namely, the angle of r° the actual tilt angle of the mast has the negative value. In this case, the actual tilt angle of the mast is not displayed as being indicative of the negative rearward tilt, but displayed as being indicative of the forward tilt corresponding to the negative value.

Meanwhile, an abrupt variation in tilt angle may be generated due to the inertia and vibration of the fork truck. For avoiding any affect caused by such an abrupt variation in tilt angle, the control unit 20 reads the detected tilt sensing value within a predetermined stabilizing time so that it can display only the actual tilt angle exclusive of the abrupt variation in tilt angle.

As apparent from the above description, the present invention provides an apparatus for displaying the tilt angle of loading equipment, capable of displaying an absolute tilt angle corresponding to a composition of the tilt angle of the mast and the tilt angle of the loading equipment, thereby achieving safer and more convenient

loading and unloading work.

Moreover, the apparatus of the present invention provides superior effects where it is used to display the tilt angle of the mast of a forklift or the boom of a crane.

Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

WHAT IS CLAIMED IS:

1. An apparatus for displaying a tilt angle in loading equipment, comprising:

an angle sensor unit mounted to a mast of the loading equipment and provided with a rotation shaft rotating upon the tilting of the mast, the angle sensor unit serving to detect the absolute tilt angle of the mast with respect to the horizontal ground in the form of an electrical signal, based on the rotation amount of the rotation shaft;

a control unit adapted to convert the angle sensing signal received from the angle sensor unit into a corresponding angle, discriminating whether the tilt of the mast corresponds to a forward tilt or a rearward tilt, and controlling the display for the absolute tilt angle of the mast on the basis of the result of the discrimination; and

a display unit adapted to display the tilt angle on the basis of display data received from the control unit.

2. An apparatus in accordance with claim 1, wherein the angle sensor unit comprises:

a sensor case mounted to the mast and provided with a fixed plate supporting the rotation shaft;

a sensor fixedly mounted on one end of the rotation shaft, the sensor having a resistance variable depending on the rotation amount and direction of the rotation shaft; and

a rotation balance fixedly mounted at the upper end thereof and

on the other end of the rotation shaft.

3. An apparatus in accordance with claim 2, wherein the sensor comprises:

a variable resistor electrically connected at a central portion thereof to a ground; and

a movable terminal adapted to generate a variation in resistance depending on the rotation amount of the rotation shaft and thereby define a pair of variable resistance regions on the variable resistor respectively in both sides thereof;

whereby the sensor outputs, as sensing signals, a voltage detected at the movable terminal and voltages detected at respective ends of the variable resistance regions signal.

4. An apparatus in accordance with claim 3, wherein the variable resistance regions of the sensor have variable ranges corresponding to tilt angle sensing ranges of forward 90° and rearward 90° , respectively.

5. An apparatus in accordance with claim 1, wherein the control unit performs a control operation for displaying the tilt angle exclusive of an abrupt variation in tilt angle generated due to the inertia or vibration of the loading equipment.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report) 14	Application number GB 9420440.1
Relevant Technical Fields (i) UK Cl (Ed.M) B8L (LFB, LFC, LFX) B8H (HFD) G1N (ACNI) (ii) Int Cl (Ed.5) B66F 9/08, 17/00 B66C 15/06	Search Examiner D MCMUNN Date of completion of Search 6 DECEMBER 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1-5

Categories of documents

X:	Document indicating lack of novelty or of inventive step.	P:	Document published on or after the declared priority date but before the filing date of the present application.
Y:	Document indicating lack of inventive step if combined with one or more other documents of the same category.	E:	Patent document published on or after, but with priority date earlier than, the filing date of the present application.
A:	Document indicating technological background and/or state of the art.	&:	Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	WO 79/00330 A1	(PETERSSON) see particularly lines 4-10, page 3	1,5
X	US 3865265	(BRUDI) see particularly lines 42 to 52, column 3	1,5

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).